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Analysis of biomass residues potential for electrical energy generation in Albania

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ABSTRACT

This paper presents the status of research of biomass potential for producing electrical energy in Albania. Biomass potential can be generated by different sources. Three types of biomass energy sources are included: dedicated bioenergy crops, agricultural and forestry residues and waste. The technical electrical energy considered in this study was calculated with two converting techniques: (1) combustion of the feedstock directly in an incinerator and then driving a steam generator for producing electrical energy and (2) production of biogas from an anaerobic digester and running a turbine for electrical energy generation. Analysis of the potential biomass resource quantity was computed according to statistical reports, literature review and personal investigations. From the biomass residue potential was calculated in terms of the theoretical energy content (total heating value) of every type of feedstock and the technical energy content for every Albanian prefecture according to different burning processes and different operation efficiencies. Results show that Albania was producing around of 4.8 million tons of dry biomass in year 2005. The theoretical energy content of biomass in Albania was 11.6 million MWh/a, and the technical electrical energy production was 3 million MWh/a. The electrical energy produced is equivalent to 45.8% of total Albania Country annual electrical consumption. In Albania Country, residues from agriculture, forest and urban waste represent a large biomass potential. By actual conversion techniques it is possible to generate one third of the theoretical heat energy into technical electrical energy. The use of heat from cogeneration plants depends on local heat provision conditions. It is another big energy potential but excluded in this study, so the rest of energy is considered as heat losses.

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1. Introduction

Albania is located in South-eastern Europe, in the west of the Balkan Peninsula (Fig. 1).

It is part of subtropical belt with humidity of the northern hemisphere and is part of the Mediterranean climatic zone characterized by a short humid winter and a hot dry summer. Rainfalls account for 1430 mm per year, where 70% of them are concentrated in the cold half part of the year and 30% in the warm part. Vegetation in Albania is diversified. About one third of the country's surface is covered by bushes and forest trees, approximately 3200 kinds of plants or 29% of the species of the European flora and 47% of the Balkan flora is found in Albania territory [1].

Biomass as a source of energy is closely related to forest residues, agriculture residues, animal waste and urban waste potential and availability [2]. In Albania, residues from agriculture, forest and urban waste represent a large biomass potential.

Electrical energy supply in Albania is based only on two main sources, on hydropower energy and thermo power energy. Low diversification on the supply side was leading to lack of electrical energy in the demand side. Albanian power generation capacity is 1659 MWh/day in which 87% are produced from hydropower plants (HPP) and 13% are produced from thermal power plants (TPP) [3]. To meet the country's electricity demands a total of 1800–2000 MWh/day. Low diversification on the supply side was leading to lack of electrical energy in the demand side. The present power system meets only 70–80% of the total demand, causing electricity load shedding to customers during the peak winter period [3].

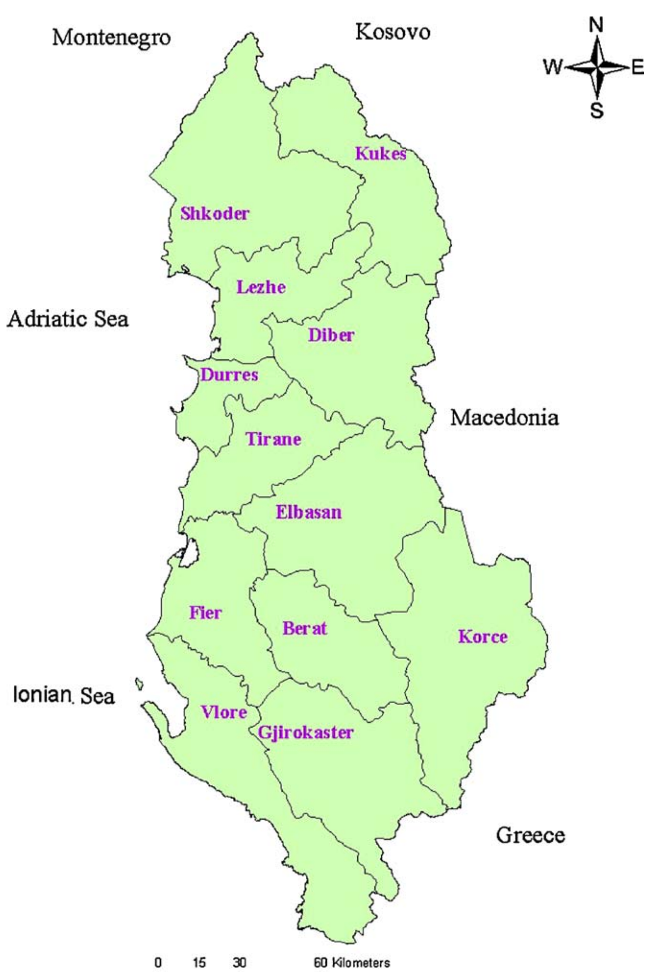

Fig. 1. Albanian country with its prefecture division and neighbouring countries.

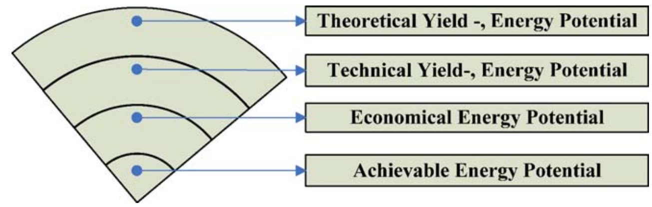

Fig. 2. Boundaries of potential energy types and yields.

Renewable energy used in Albania as primary energy production are solid biomass coming from forest (6250 GWh), hydro power which contribute with 95% of the total electrical energy production (5466 GWh) and recently solar energy (80 GWh) [4]. It was assumed that energy from biomass residues can contribute a higher share of whole energy production. To find the amount of dedicated bioenergy crops, agricultural and forestry residues and waste can contribute to energy production, in this study was calculated the theoretical potential energy content and then according to conversion processes[1] was calculated the technical energy content per prefecture in relation to efficiency used.

We can distinguish four types of energy potential; theoretical energy, technical energy, economical energy and achievable energy and two types of biomass yield potential, theoretical yield and technical yield (Fig. 2).

Theoretical yield potential include is all biomass production (in terms of weight) in a certain area and depends on the type of biomass and environmental specific of the region. The theoretical yield potential unit is Mg/ha or m^3/ha (e.g. Mg/ha wheat, m^3/ha wood) [5].

Theoretical energy potential (or total heating value) is the total energy released in a combustion process from a certain material (organic or inorganic). The theoretical energy describes the maximal energy content of the combusted material and the unit is in MJ/kg or MJ/l.

Technical yield potential is the share of theoretical yield potential which is useful as biomass under the given techniques of manipulation. Not all the biomass production is possible to collect from the field, a part of it are the underground biomass which is being left in soil and the upper part with the available techniques is not possible (and desired) to be collected [5].

Technical energy potential describes the actual useful energy part from theoretical energy potential of the combustible material (woodchips potential, biogas potential), under consideration of given converted technique (e.g. CHP, biogas turbine generator, and incinerator process), structure, efficiency, ecologic and law restriction. Due to different converting techniques available in market it is not possible to use all the theoretical energy potential but part of it [5].

Economical energy potential is one part of the technical energy potential which respectively is being used in the economic energy system. Economic aspects such as cost and benefit, conventional system or modern system and energy price are being considered in evaluating the economical energy potential [6].

Achievable energy potential is a part of economical energy potential under specified terms of condition. It is the actual part of energy use that could be achieved through normal market forces, equipment efficiency and utility energy – efficiency programs [6].

In this study the potential of biomass residues for the production of renewable electrical energy from biomass in Albania is analysed. From the biomass residue potential was calculated in terms of theoretical energy content (total heating value) of every type of feedstock and the technical energy content according to different burning processes and different operation efficiencies.

[1] Direct use as a fuel (power station) or produce of fuel and then burning it (biogas system).

2. Materials and methods

2.1. Energy from biomass

Biomass energy is consisting of the following four main fonts: agriculture residues, forest residues, animal residues and urban waste. The total agriculture area, including forest and pasture is around 2.1 million hectares; the arable lands area amounts to 24% (Fig. 3) [7,8]. Forest area occupies 36% of the total area and pasture only 15%. The other 25% are inland waters, roads and buildings.

Residues from plant production are the amount of crop that remains, after the collection of the main product. Residues are depending on a wide range of local conditions, the primary factors influencing the amount of crop residues are the type and variety of crops planted and their yield.

The most important crop residues in Albania are that from cereals (wheat, maize, rye, barley, and oats) with around 147,000 hectares of cultivation, potatoes and recently vegetable products are showing significant importance [8,9]. Up to now, agriculture residues are not being used for energy generation in any case but only for animal feed or green fertilization.

Animal residues are another form of biomass that is being well known for energy generation. The amount of animal waste residues depends on type and size of animals, number of animal population, domestic animals or confined feedlots and population animal density for one location [9]. Animal residues are mainly used as fertilizer. There does not hold up any system of converting animal residues into energy [9].

Forest residues are all slash left in the forest following logging operations; stems, tops, stumps, foliage and damaged trees that are not merchantable; furthermore wood and bark residues accumulated at wood manufacturing industries [10]. Albania with forest area of 1,502,161 ha is generating around 2.2 million m^3 of forest residues per year [11]. This amount of wood energy is used for warming houses, cooking on open fire and stoves in a traditional way [11]. Equipment such as sophisticated incinerator for wood burning processes does not exist [12].

Urban wastes are basically two types of municipal refuse that offer opportunities for energy recovery: (i) municipally solid waste (MSW, urban refuse, garbage) and (ii) biosolids (sewage, sludge). As the population of urban areas is increasing, the urban disposal is increased as well. Another positive correlation exists between increase of welfare and generation of urban waste. Albanian citizens are generating approximately 0.219–0.307 ton urban waste per habitant and year [9].

2.1.1. Residues from plant production

Agriculture crop residues were obtained by calculating the production of agriculture crops in terms of yield and area in hectares for the year 2005 [13] and then using different conversion models do derive the quantity of crop residues (straw, stover) from yield. A sustainable collection factor was used across the board of all crops for getting an estimate of the potential harvestable residues with respect to soil fertility conservation concerns. Moisture content of crop residues was used to determine the final dry biomass.

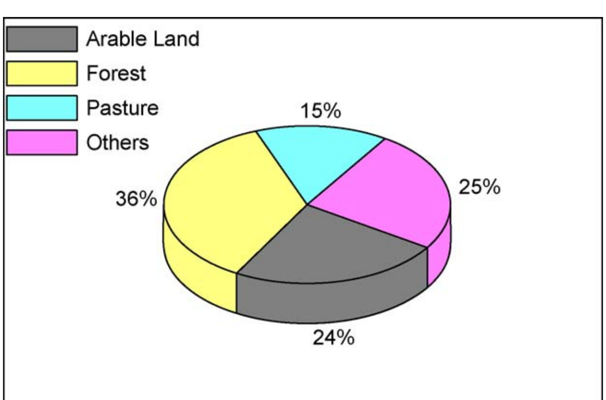

Fig. 3. Land structure in Albania in year 2005 [8].

Wheat straw biomass was calculated from a linear correlation which permits computation of the quantity of straw generated if the wheat yields are known and then multiplying collection factor availability for sustainable production and moisture content of the crop [14]. The least squares relationship is as follow:

$$m_{\mathrm{WS,dm}} = y_{\mathrm{r}} \cdot a \cdot \left(1 - \frac{w}{100}\right)$$

where ($m_{\mathrm{ws,dm}}$) correspond to mass of wheat straw in ton of dry matter, $y_{\mathrm{r}} = \left(\frac{69.76y + 1067.7ac}{2000}\right)$ is a linear correlation to permit computation of the quantity of straw generated if the wheat yields are known [14], (a) is availability factor, (w) is the wet basis moisture content of wheat straw. According to Frear et al., a sustainable collection factor of 25% and a moisture content of 28% was used to determine the final dry biomass.

Corn stover residues were obtained from production of corn in terms of yield in ton/ha and then using conversion equation from corn to stover:

$$m_{\mathrm{CS,dm}} = y \cdot r \cdot a \cdot \left(1 - \frac{w}{100}\right)$$

where ($m_{\mathrm{cs,dm}}$) corresponds to mass of corn stover in ton of dry matter, (y) is the yield per hectares in ton, (r) is the residual factor, (a) is the availability factor, (w) is the wet basis moisture content of corn stover. According to Klass [15,16] residue factor was set to 1.1, availability factor to 25% and moisture content to 47% to get total straw production.

Barley straw residue was calculated from multiplying the prefecture yield total with the residue factor and availability factor, generating the total mass of residue.

$$m_{\mathrm{bs,dm}} = y \cdot r \cdot a \cdot \left(1 - \frac{w}{100}\right)$$

where ($m_{\mathrm{bs,dm}}$) corresponds to mass of barley straw in ton of dry matter, (y) is the yield per hectares in ton, (r) is the residual factor, (a) is the availability factor, (w) is the wet bulk moisture content of barley straw. According to Frear et al. [13], a residue factor of 2.5 and an availability factor of 25% were multiplied with the moisture content of 9% for estimating the real value of straw.

Rye straw residue was calculated from multiplying the prefecture yield total with residue factor and availability factor. Formula used was as follow:

$$m_{\mathrm{rs,dm}} = y \cdot r \cdot a \cdot \left(1 - \frac{w}{100}\right)$$

where ($m_{\mathrm{rs,dm}}$) corresponds to mass of rise straw in ton of dry matter, (y) is the yield per hectares in ton, (r) is the residual factor, (a) is the availability factor, (w) is the wet basis moisture content of rise straw. According to Klass [15,16], a residue factor of 2.5 and a collection factor of 25% were multiplied with the moisture content of 10% for estimating the dry biomass value of straw availability for feedstock.

Oats straw residue was calculated form multiplying the prefecture yield with residue factor and availability factor. Formula used was as follow:

$$m_{\mathrm{os,dm}} = y \cdot r \cdot a \cdot \left(1 - \frac{w}{100}\right)$$

where ($m_{\mathrm{os,dm}}$) corresponds to mass of oats straw in ton of dry matter, (y) is the yield per hectares in ton, (r) is the residual factor,

(a) is the availability factor, (w) is the wet basis moisture content of oats straw. According to Klass [15,16], a residue factor of 3.01 and a collection factor of 25% were multiplied with the moisture content of 9% for evaluating the dry biomass of straw.

Mixed vegetable residues were obtained by prefecture level of production in terms of yield for the year 2005. Formula used was as follow:

$$m_{vr,\mathrm{dm}} = y \cdot p \cdot \left(1 - \frac{w}{100}\right)$$

where ($m_{\mathrm{vr,dm}}$) corresponds to mass of vegetables in ton dry matter per year, (y) is the yield per hectares in ton, (p) is the processing solid waste factor, (w) is the wet bulk moisture content of vegetable residue. Frear et al. [13], have determine the processing solid waste factor of 13% and the moisture content of 90% for the vegetable products.

Cull potatoes residue value was calculated using total yield production per prefecture multiplied by a harvesting factor [17].

$$m_{\mathrm{pr,dm}} = y \cdot p \cdot \left(1 - \frac{w}{100}\right)$$

where ($m_{\mathrm{pr,dm}}$) corresponds to mass of potatoes in ton dry matter per year, (y) is the yield per hectares in ton, (p) is the processing solid waste factor, (w) is the wet bulk moisture content of potatoes residue.

Frear et al., have determine the processing solid waste factor of 10% and the moisture content of 81% for the potatoes residue.

Agriculture biomass energy potential of wheat, corn, barley, rye and oats was estimated with combustion processes[2] as direct fuel [13,18,19]. An overall efficiency of 30% was chosen, which a reachable level under current available technology is.

2.1.2. Animal waste

Animal manure values were obtained by taking the number of population for each kind of animal for the year 2005 per prefecture [13]. Formula used for animal waste was as follow:

$$m_{\mathrm{aw,dm}} = Nr_{\mathrm{a}} \cdot (m_{\mathrm{dm}}365) \cdot a$$

where ($m_{\mathrm{aw,dm}}$) is the mass of animal waste in ton dry matter per year, ($\mathrm{Nr_a}$) is the number of animal, (m_{dm}) is the manure production in dry matter kg per head and day, (a) is the collection availability factor.

A collection availability factor depending on dimensions and duration of stock farming per year of manure was used for every type of animal according to Albanian conditions [20] (Table 1).

2.1.3. Forest residues

The amount of forest-derived biomass is based on an analysis of forest resources inventories calculated by Albanian National Forest Inventories [21]. Fig. 4 demonstrates the forest location in Albanian Country, according to ANFI classification of forest biomass.

From ANFI report has been taken these parameters for evaluation of forest residues, the forest area per prefecture and forest characteristics such as volumes in m^3, type of forest, ownership, management system and natural growth rate [21].

The forest is owned by the state (99.06%), the private ownership is rather rare but a tendency of privatisation and establishment of communal forest has been observed in the last decade [21]. From Table 2 it is shown that 84% of the total volume is located in high forest and around 16% in coppice forest. In terms of management system it is known that 30% of forest land is covered by high forest, 41% by coppice forest and 29% of the area from shrub forest. For the estimation of forest biomass residues only two types of forest are relevant and taken into consideration: the high forest and the coppice forest with their respective characteristics [21].

Studies on growth for all forest area in Albania have revealed a total of 1.53 m^3/ha per year, this means around 1.6 Mio m^3/year of new biomass [11]. From the literature [11] it is known that around 2.2 Mio m^3 are being used for energy in Albania.

According to management system only high forest and coppice forest are used in biomass generation. The shrub forest is left aside for recreation and regeneration practices. In this study the area per prefecture was given separately for all type of forest. This made

Table 1
Livestock manure production $m_{\mathrm{aw,dm}}$ in Albania together with their collection availability factor a and methane yield.

Livestock/poultry	Manure, $\mathrm{kg_{dm}}$ per head and day[a]	Collection factor[b]	Methane yield m^3/kg
Cattle	3.5	80%	0.21
Cows	6.08	90%	0.21
Sheep	0.45	60%	0.02
Milked sheep	0.45	60%	0.02
Goats	0.45	60%	0.04
Milked goats	0.45	60%	0.04
Pig	0.39	95%	0.33
Equidae	3.9	60%	0.021
Horse	4.9	60%	0.021
Chicken	0.15	75%	0.29

Source: [13,20].
[a] 1 kg dry mass of bedding is added for cattle, cows, equidae and horse.
[b] The amount of manure production and collection factor is according to Albania condition [20]. Livestock Manure Production. Stuttgart, 2007 (Specialist interview).

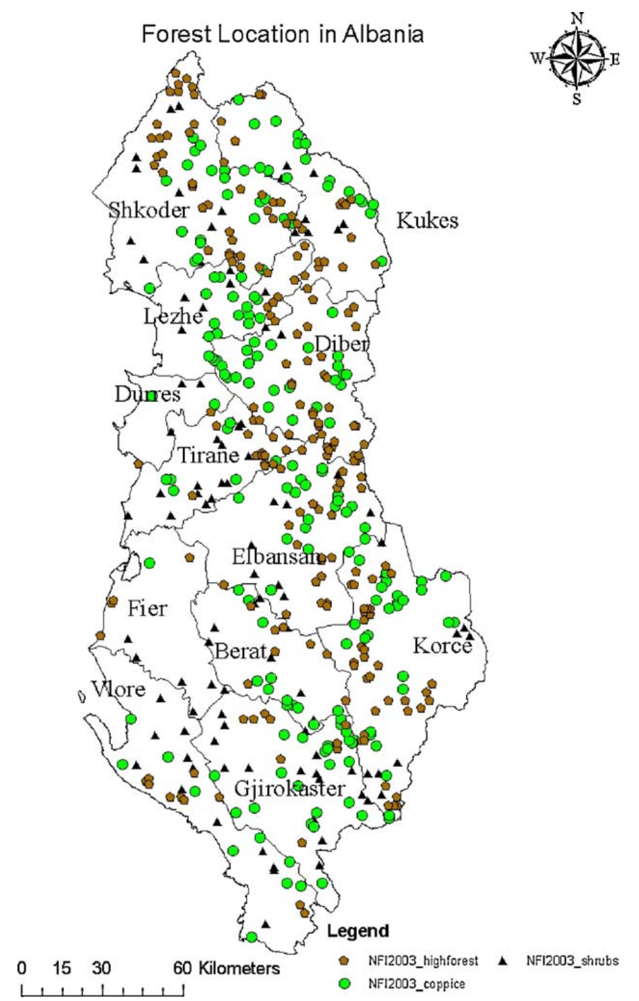

Fig. 4. Forest location in Albania according to ANFI [9].

[2] Only wheat, corn, barley, rye and oats were used as direct fuel, vegetable and potatoes residue were used as biogas production because they have high moisture content and low heating value.

Table 2
Albanian forest parameters [9].

Forest type	Area in ha	Management system in %	Total volume in 1000 m^3	Total volume in Mio ton	% of total biomass
High[a]	448,922	30%	59,112	44.95	84.0%
Coppice[b]	623,799	41%	14,235	8.10	15.8%
Shrubs[c]	429,440	29%	198	0.11	0.2%
Total	1,502,161	100%	73,545	53.16	100%

[a] High forest is all woodland management to encourage straight, single-stemmed trees which are often felled for timber when mature.
[b] Coppice forest is all woodland which has been regenerated from shoots formed at the stumps of the previous crop trees, root suckers, or both.
[c] Shrub forests are all type of woodland that include the height range of 0.5–5 m.

possible to calculate the amount of forest biomass separately for each type of forest.

$$m_\mathrm{f} = [(f_\mathrm{ah} \cdot n_\mathrm{h}) + (f_\mathrm{ac} \cdot n_\mathrm{c})] \cdot a$$

where (m_f) is mass of forest residues in m^3, (f_ah) is forest area of high forest in hectares, (n_h) is the natural growth rate of high forest in m^3/ha, (f_ac) is coppice forest in hectares, (n_c) is the natural growth rate of coppice forest in m^3/ha, (a) is the collection availability factor on a sustainable base. According to Kotro et al. [11] a sustainable collection factor of 80% was used for determining the total biomass extractable from forest.

Biomass potential value are calculated in m^3/a and converted to kg/a using a conversion factor of 1.4 m^3 = 1 ton to calculate the energy content (MJ/kg). The species under investigation were (Fagus silvatica, Quercus species for high forest and Pinus nigra, Abies species for coppice forest) of Albania forest [21].

2.1.4. Urban waste

The components of municipal solid waste (MSW) in Albania are paper, cardboard, plastics, wood and other combustible materials. In a small quantity are included metals, glass and other non-combustible materials [7].

The conversion technology waste to energy in Europe is burning unprocessed waste to generate steam (or hot water) for local heating and electric power generation. New processes were created in United States for converting waste into energy, mechanically process of waste to upgrade it to a refuse – derive fuel (RDF) for use by itself or as a coal supplement [22]. Strictly speaking, raw MSW is a form of RDF, as is shredded and metal parts are removed.

According to Ministry of Economy and Industry and Ministry of Environment, technologies for processing MSW do not exist, but in the future it is programmed the construction of CHP (combined heat power) from MSW in some main cities of Albania. In this context is being analysed the energy from MSW.

The quantity in ton/habitant/year is being provided from Ministry of Environment and the collection availability of 80%[3] [7]. The technology process of converting the MSW into energy is the heat recovery incinerator.[4] This technology uses unprocessed MSW as fuel. In heat recovery incinerator the combustion gasses passes through water walls and transfer the heat to water producing in this way steam. The generated steam is being used for running generator producing electricity.

2.2. Biomass residues energy potential

Energy potential availability from biomass resources in Albania is expressed as higher heating value (HHV). Higher heating value (HHV) also known as gross calorific value or gross energy of a fuel [23,24], is defined as the amount of heat released by a specified quantity (initially at 25 °C) once it is combusted and the products have returned to a temperature of 25 °C [25]. The HHV takes into account the latent heat of vaporization of water in the combustion products, and is useful in calculating heating values for fuels where condensation of the reaction products is practical (e.g. in an oil – fired boiler used for space heat) [25].

The HHV is possible to be measure experimentally in the laboratory, and the LHV could be calculated from HHV. Both calorific values are related through the equation:

$$(\mathrm{LHV}) = \mathrm{HHV}(1 - W) - 24.42(W + 9H_\mathrm{d})$$

where (LHV) corresponds to the lower heating value of the dry sample, W is the moisture content in percentages, and H_d is the hydrogen percentage of the dry sample [26]. The heat of vaporization of water is taken as 2441.8 kJ kg^{-1}, and the water formed during combustion is nine times the hydrogen content (%).

The calculated energy potential is opposed to the energy consumption of Albanian prefectures in year 2005. Data were taken from INSTAT [27]

2.2.1. Agricultural electrical energy production

The energy potential of each category of vegetable residues, animal waste and potatoes residues was estimated by biogas production from an anaerobic digester [13,18,19,28]. The general procedure was the calculation of methane production from animal volatile solid waste (VS) (Table 2) for every category of animal excreta in yield per unit.

The production of electrical energy was calculated by using methane in combustion processes and typical conversion efficiency of 30% was taken for calculating technical energy content of different animal wastes.

2.2.2. Forest biomass electrical energy production

The heating value of forest biomass was set to 16.6 MJ/kg [29] when it is dried in ambient condition which is the case of Albanian forest biomass. Theoretical energy content was estimated from biomass production multiplied by heating value. A conversion efficiency of 30% was used for estimating technical electrical energy generation [13].

2.2.3. Urban waste electrical energy production

Urban waste energy was calculated by the amount of RDF generated from each prefecture. There exists different RDF (Fig. 4) and every one of them has its own characteristics in appearance and composition. According to the National Strategy and Ministry of Economy and Industry of Albania, energy from RDF waste as calculated as a fuel for a combustion power station. According to literature the heating value of one kilogram MSW without processing is around 4–5 MJ/kg [22]. A conversion efficiency of 30% [22] was used for estimating technical electrical energy generation.

[3] Not all the MSW generated are being collected a part of them is dumped into rivers, ridges even sea side.
[4] It is planed in the future construction of this technology Ministry of Economy and Industry.

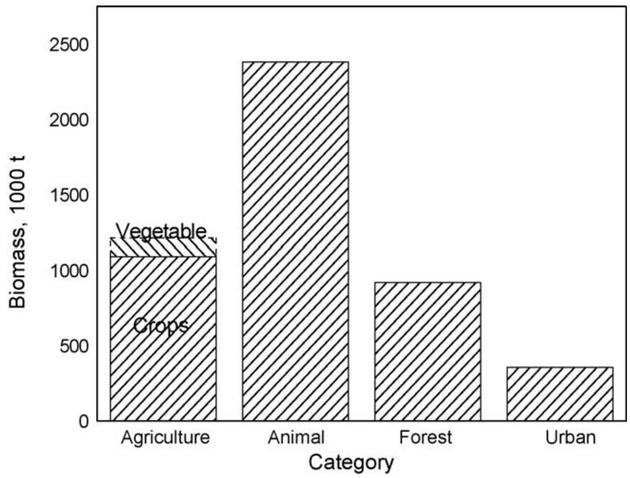

Fig. 5. Biomass inventory from different categories of biomass production.

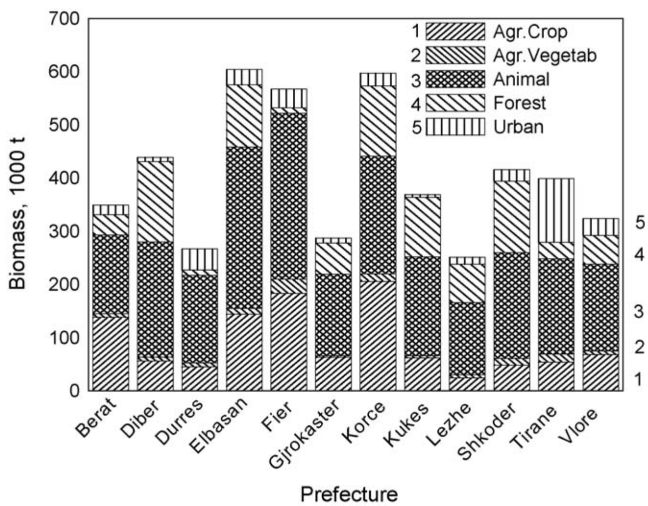

Fig. 6. Total biomass production per prefecture in tons in 2005.

3. Results

3.1. Biomass potential inventories

Results show that Albania had a sustainable annual production of 4.8 million tons of dry biomass in year 2005 (Fig. 5), which is capable of producing electrical energy.

Majority of biomass production came from animal waste, followed by agricultural residues, which is separated in agriculture crops and agriculture vegetables.[5] The animal wastes contribute with 49% to the country biomass production, agriculture residues with 25%, forest residues with 19% and urban waste with 7% respectively.

Fig. 6 differs from Fig. 5 in that the biomass is related to prefecture instead of category. It is clearly identified the prefectures with bigger amount of biomass like Elbasan, Fier and Korce and as well as the biomass composition category per prefecture (Agriculture Crops, Agriculture Vegetables, Animal Waste, Forest Residue and Urban Waste).

There are 36% of total biomass productions in three prefectures Elbasan (12%), Fier (12%) and Korce (12%).

Table 3
Electrical energy consumption of Albania and technical electrical energy potential from biomass in 2005.

Prefecture	Electrical energy consumption (in 1000 MWh/a)	Technical electrical energy potential (in 1000 MWh/a)	Electrical energy available from biomass (in %)
Berat	352	234	66.5
Diber	315	310	98.4
Durres	659	126	19.1
Elbasan	673	382	56.8
Fier	724	292	40.3
Gjirokaster	203	168	82.8
Korce	502	441	87.8
Kukes	194	255	131.4
Lezhe	304	164	53.9
Shkoder	475	293	61.7
Tirane	1.856	219	11.8
Vlore	460	184	40.0
Total	6.717	3.075	45.8

Animal waste biomass dominates in all prefectures and the total animal waste potential reaches 2.3 million tons. Urban waste potential is the smallest biomass source, in all prefectures except Tirane prefecture which has high number of habitants and generates around 120 thousand tons of MSW. The whole MSW generation is around 355 thousand tons.

3.2. Theoretical and technical energy potential in Albania

Study results show that it is possible to generate 11.6 million MWh/a of energy theoretically and around 3 million MWh/a of electrical energy technically from 4.8 million tons of dry biomass.

The electrical energy of 3 million MWh/a is equivalent to about 45.8% of total annual electrical consumption of Albania (Table 3). Table 3 is showing the electrical energy consumption per prefecture in year 2005, the potential electrical energy production from biomass per prefecture and the percentage that electrical biomass energy could substitute per each prefecture.

Table 3 shows that the prefectures fulfil their needs of electrical energy to different extend. Kukes prefecture fulfils its needs by 131.4%, meaning that theoretically, the prefecture could be a net exporter of energy. This prefecture produces around 369 thousand tons of dry biomass in which 112 thousand tons are forest biomass. Other prefectures such as Diber (98.4%), Gjirokaster (82.8%) and Korce (87.8%) show high potential of fulfilling their needs with electrical energy generated from biomass. The reason of high electrical availability from biomass for some prefectures it is not only because of high amount of biomass availability but also because of low energy consumption, e.g. Kukes prefecture has the lowest electrical energy consumption. Tirane prefecture for instance has only 11.8% of electrical energy potential to be fulfilled by the biomass electrical energy production because of its high electrical energy consumption of 1.8 million MWh/a.

Fig. 7 demonstrates the theoretical and technical energy generation per prefecture in MWh/a. As expected, in the prefectures with high amount of biomass production (Elbasan, Fier and Korce) there is high theoretical energy generation.

The same results were taken for technical electrical energy generation (Fig. 7b), prefectures with high theoretical energy have as well high technical electrical energy production. Forest biomass and agriculture biomass show the highest amount of technical electrical energy generation. Urban waste shows high technical energy generation only in Tirana prefecture (Fig. 7b).

[5] This separation is due to different processes of conversion of biomass into energy (agriculture crops are converted with direct combustion and agriculture vegetables with biogas production).

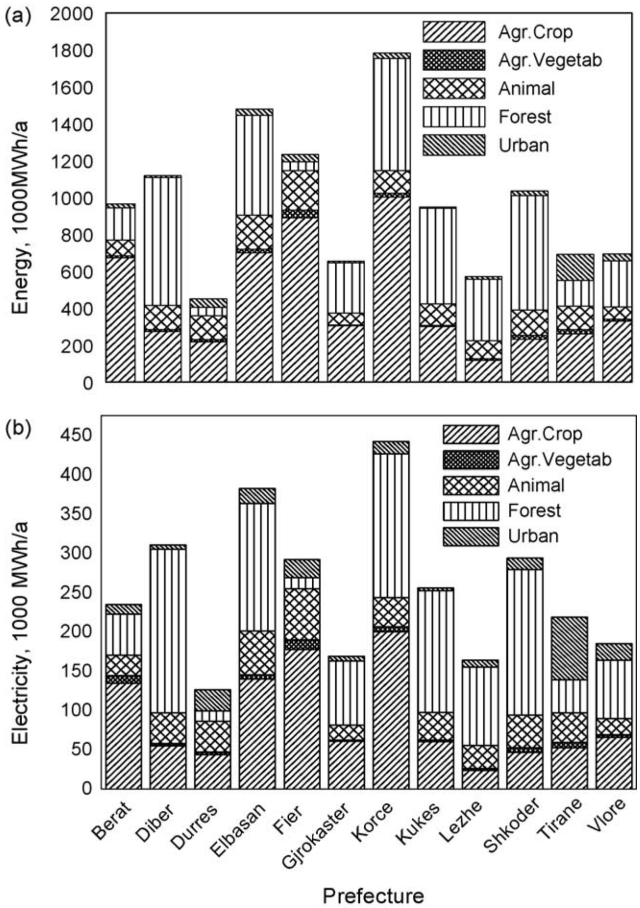

Fig. 7. Theoretical (a) and technical (b) energy content of biomass per prefecture in Albania.

4. Conclusion

Biomass inventory for electrical energy generation in Albania was established. Every category of biomass was estimated separately for each prefecture. The potential of biomass production per prefecture was identified. From biomass inventory it was possible to estimate the theoretical energy content (total heating value) and the technical electrical energy content (via assumed combustion and anaerobic digester) for each type of biomass.

Results show that there is a high potential of electrical energy generation from biomass. From the actual country electricity consumption is possible to produce around 45% of electrical energy from biomass energy generation.

The method applied is giving an overview of the biomass potential for producing electrical energy, but it does not take into consideration issues like food security, competing uses of biomass with other sectors and economical aspects such as cost and benefits. Therefore, future studies should focus on those issues for defining the achievable energy potential through regular market forces and utility energy efficiency programs.

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